
Marine Physical Laboratory

Autonomous Acoustic Source

William S. Hodgkiss

Supported by the
Office of Naval Research
Grant N00014-00-1-0377

Final Report

June 2002

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20040809 094

REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.				
1. Agency Use Only (Leave Blank).		2. Report Date. June 2002		3. Report Type and Dates Covered. Final Report
4. Title and Subtitle. Autonomous Acoustic Source			5. Funding Numbers. N00014-00-1-0377	
6. Author(s). William S. Hodgkiss			Project No. Task No.	
7. Performing Monitoring Agency Name(s) and Address(es). University of California, San Diego Marine Physical Laboratory Scripps Institution of Oceanography San Diego, California 92152			8. Performing Organization Report Number.	
9. Sponsoring/Monitoring Agency Name(s) and Address(es). Office of Naval Research Ballston Centre Tower One 800 North Quincy Street Arlington, VA 22217-5660 Jeffrey Simmen, ONR 3210A			10. Sponsoring/Monitoring Agency Report Number.	
11. Supplementary Notes.				
12a. Distribution/Availability Statement. Approved for public release; distribution is unlimited.			12b. Distribution Code.	
13. Abstract (Maximum 200 words). An autonomous acoustic source buoy system has been designed and fabricated for use in the collection of underwater acoustic propagation data. The system consists of a surface buoy which provides battery power, signal waveform synthesis, power amplification, system control, and wireless local area network (WLAN) communications.				
14. Subject Terms. acoustic source buoy, waveform synthesis, power amplification, system control			15. Number of Pages. 8	
			16. Price Code.	
17. Security Classification of Report. Unclassified	18. Security Classification of This Page. Unclassified	19. Security Classification of Abstract. Unclassified		20. Limitation of Abstract. None

DURIP: Autonomous Acoustic Source

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Abstract

An autonomous acoustic source buoy system has been designed and fabricated for use in the collection of underwater acoustic propagation data. The system consists of a surface buoy which provides battery power, signal waveform synthesis, power amplification, system control, and wireless local area network (WLAN) communications.

Hardware Summary

The hardware components for the autonomous acoustic source system were acquired under three fabrications: (1) Buoy Mechanical/Structural Assembly, (2) Waveform Generation/Amplification, Communications, and Power Distribution Electronics, and (3) Shipboard Control Computer/Communications. The following sections will describe each of these in detail.

A. Surface Buoy and Battery Pack

The surface buoy provides flotation for the large battery pack as well as a mounting platform for the system control computer, GPS antenna for time code, 460 MHz antenna for a UHF radio modem, and 2.4 GHz antenna for the wireless local area network (WLAN) providing connectivity to the ship (see Fig.1 - taken of an identical buoy fabricated for a separate project). The buoy is a polyethylene foam float with a polyurethane outer jacket. It weighs 3375 lbs of which 1750 lbs is the battery pack. The battery pack consists of a rack of 32, 12 volt, 65 AH gel-cell batteries wired in series to provide 384 volts DC for the underwater pressure case (see Fig. 2). The rack fits inside an anodized aluminum tank which is surrounded by the foam float. The power amplifiers are mounted on the underside of the lid to the tank. On top of the tank is a waterproof box containing the card cage for the waveform synthesis and system control computer. A tripod rises 21' above the buoy to provide a mounting for the GPS, 460 MHz, and 2.4 GHz antennas. Below the buoy is a 10' section of TV tower with 200 lbs of weight on the bottom for stability. Lastly, an acoustic release for the buoy mooring and RF-beacon/flasher for locating the buoy have been included.

B. Waveform Synthesis, Power Amplification, System Control, and Communications

Waveform synthesis is carried out by a compact PCI (peripheral control interconnect) chassis with a Pentium-III 600 MHz CPU running Windows NT, a National Instruments PXI-6713 D/A for generating multiple analog waveforms, and a National Instruments PXI-6052E A/D for collecting monitor hydrophone data. Data storage is provided by IDE, 30 GB, 2.5" disk drives. All waveform synthesis, D/A, and A/D functions are carried out in LabVIEW.

Power amplification is provided by a 5-channel, Instruments Inc., switching power amplifier. Thus, as many as 5 separate transducers can be controlled from the buoy at the same time.

The system control computer consists of a compact PCI chassis with a Pentium-II 450 MHz CPU running Windows NT, a National PXI-6071E A/D for collecting ancillary time series data from a variety of environmental and motion sensors on the buoy, a GPS time code interface for synchronization to GPS time (Bancom BC637 CPCI), and an interface for the wireless local area network. Data storage is provided by IDE, 30 GB, 2.5" disk drives. In addition, the control electronics package includes a 460 MHz UHF radio modem and a Persistor CF1 microcontroller for secondary control. All control functions are carried out in LabVIEW.

Primary communications with the buoy are provided by a 2.4 GHz, direct sequence spread-spectrum (DSSS), wireless local area network (WLAN) (Lucent WaveLAN 802.11). The desktop of the system control computer is operated remotely through the wireless LAN on the ship. The buoy has a simple 7 dBi omnidirectional antenna mounted at the top of the tripod (~25' off the sea surface) while the ship uses directional antennas. Amplifiers on the buoy and the ship provide 1 watt of transmit power, up to 30 dB of gain on receive, and bandpass filtering at 2.4 GHz. The amplifiers are placed as close as possible to the antennas to reduce the effects of cable losses during transmit. If the wireless LAN becomes inoperative, a backup serial link through the 460 MHz UHF radio modem provides a means to power down the pressure case and to reboot the system control computer.

C. Shipboard Control Computer and Communications

Although autonomous operation of the acoustic source system is one mode of operation, real-time communications with the hardware is essential for experiments where modification of the source transmission schedule or source waveforms themselves is necessary. Thus, a wireless local area network (WLAN) between the ship and system control computer on the surface buoy has been included in the design. The shipboard computer itself consists of a 1.2 GHz CPU and associated peripherals. In addition, a duplicate of the buoy communications hardware is located on the ship. These include the 2.4 GHz wireless local area network along with directional antennas (both Yagi and parabolic dish) for primary communications and the 460 MHz UHF radio modem for backup purposes.

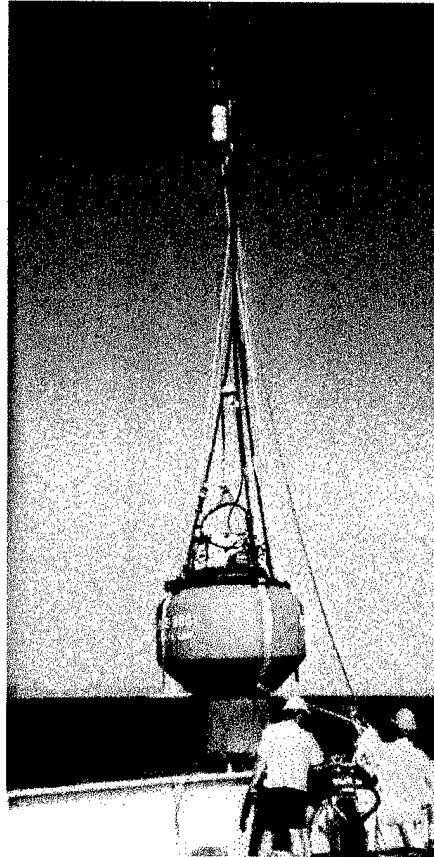


Fig. 1. The surface buoy provides battery power, waveform synthesis, power amplification, system control, and wireless local area network (WLAN) connectivity.

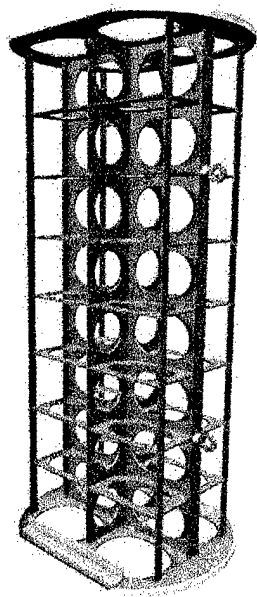


Fig. 2. The battery rack holds 32 batteries and fits inside an aluminum anodized tank surrounded by the foam float.

Fund 32972A N00014-00-1-0377 HODGKISS 13% 9/01
PI Hodgkiss, William S.

Agency OFFICE OF NAVAL RESEARCH (ONR)

Grant Number N00014-00-1-0377

Funding Amount \$ 117,918.00

Grant Dates 03/01/2000-09/30/2001

Budget Dates 03/01/2000-09/30/2001

Overhead Rate M130FG MODIFIED-FEDERAL-GRANT-13.0%

Total Salaries and Benefits

11,820.83

Total Supplies & Expenses

5,240.01

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Total Fabrication of Autonomous Acoustic Source Waveform Generation/Amplification
Communications, & Power Distribution Electronics

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Total Fabrication of Autonomous Acoustic Source Shipboard Control Computer/ Communications				13,840.68
TOTAL EQUIPMENT COSTS				128,850.86
TOTAL DIRECT COSTS				145,911.70
INDIRECT COSTS 13% OF MTDC				2,217.91
TOTAL PROJECT COSTS				148,129.61
N00014-00-1-0376 AWARD				117,918.00
CONTRIBUTION BY UNIVERSITY				30,211.61

ONR/MPL REPORT DISTRIBUTION

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